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ABSTRACT

The effects of a series of science lessons on reading readiness were investigated. Kindergarten children from three schools in central-city Milwaukee were the subjects. Twenty children from the University of Wisconsin-Milwaukee Laboratory School were used to try out the procedures and materials used in the prepared science lessons. Twenty children in an inner-city school comprised the experimental group that received the series of science lessons. The third kindergarten class was the control group and received no science lessons. Fifteen lessons were prepared, and twelve were presented to the original try-out class and the experimental class. Each lessson took 1 week to complete (30 minutes per day for 3 days). Assessment of the study was made by teachers and children, and all children received the Metropolitan Reading Readiness Test. Among the conclusions were (1) that the children who had science lessons tended to score higher on the reading readiness test and (2) that the experimental group exhibited higher first-grade reading achievement. References and tables are given, and unit plans and materials for the 15 science lessons are appended. (DE)

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THE EFFECT OF KINDERGARTEN SCIENCE EXPERIENCES ON READING READINESS

Donald B. Neuman

The University of Wisconsin—Milwaukee

Milwaukee, Wisconsin 53201

U.S. DEPARTMENT OF

HEALTH, EDUCATION, AND WELFARE

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SUMMARY

This is the final report of a pilot study designed primarily to investigate the effects of a series of science lessons on the reading readiness of children attending a central-city Milwaukee school. The science lessons were designed to sharpen children's observational skills while building specific science concepts. Reading readiness was evaluated by means of a standardized reading readiness test.

One kindergarten class at the University of Wisconsin-Milwaukee Laboratory School (N=21), one kindergarten class at the Twelfth Street School (an inner-city school) (N=20), and a group of kindergarten children at the Hopkins Street School (N=20) made up the population for the study. The class at the Laboratory School was used to try out procedures and materials used in the science lessons. The class at the Twelfth Street School was the experimental group and had the series of science lessons following the try-out at the Laboratory School. The group of children at the Hopkins Street School was designated the control group and had no science lessons.

The objectives of the Study were: (1) to investigate the appropriateness of a variety of science-oriented materials for kindergarten-age children; (2) to assess procedures for presenting a series of science lessons; (3) to evaluate a child's ability to make specific visual, auditory, and tactual discriminations after having the lessons; (4) to compare scores on a test of reading readiness of children who had the science experiences to scores of children who did not have the science experiences; and (5) to qualitatively assess the reading achievement in first grade of children who had the science experiences in kindergarten.

Lessons were introduced to children at the Laboratory School in February, 1969. Approximately two weeks later the same lessons were initiated in the kindergarten class at the Twelfth Street School. Fifteen lessons were prepared and twelve of the lessons were ultimately presented to all of the children in both groups. Each lesson took approximately one week to complete. Lessons were taught for thirty minutes per day and three days per week.

The lessons were based in part on the materials and procedures used in two of the new elementary science programs and in part on procedures designed by the investigator to meet the criteria of the study. In each lesson the general procedure was similar. A child was given materials to manipulate in an initial unstructured period. A more structured phase involving these materials followed. Each lesson was concluded by a more abstract phase. Here the child observed pictures or sketches of the materials he had been previously using and was asked to manipulate, identify, or in some way interact with the abstract forms.

Assessment of the study took the following forms: (1) teacher feedback was elicited to determine quality of lessons and procedures; (2)

individual children were selected for evaluation after each lesson to determine achievement of lessons goals; (3) all children in the experimental and control groups were given the Metropolitan Reading Readiness Test - Form A; and (4) the first grade teachers of children who had been in the experimental group in kindergarten were asked to evaluate over-all reading achievement of children in their classes.

The following results were noted:

(1) A number of minor changes in specific lesson procedures or materials were suggested by the try-out group teacher. Of major significance was the decision to eliminate whole-group lesson evaluations and adopt individualized evaluations, instead. In addition, of the fifteen lessons initially prepared for the program, it was decided that lessons one through twelve would constitute the main body of the science series and lessons thirteen through fifteen would be optional because of their level of difficulty. After these changes in the science program were made, it was the unanimous opinion of the research staff that the lessons were appropriate for kindergarten-age children;

(2) Eight children were selected by the classroom teacher for individual evaluation following each lesson. It was found that in the ten lessons evaluated, six of eight children, on the average, achieved the desired goals of the lessons;

(3) On the Metropolitan Reading Readiness Test, children in the experimental group scored higher than children in the control group on the sub-tests: vocabulary ($p < .001$), alphabet ($p = .064$), and numbers ($p = .014$). Children in the control group scored higher than children in the experimental group on the sub-tests: matching ($p = .046$). There were no differences between groups on the sub-tests: listening and copying. On the total score the experimental group scored higher than the control group ($p = .076$);

(4) Children who had the science program in kindergarten were distributed into two first grade classes. In January, 1970 the teacher in each of the two classes rank ordered the children in terms of reading achievement. In one of the classes the teacher perceived that eight of the ten most competent readers were children who had had science in kindergarten. In the other class, eleven of the "top" thirteen children had been in the experimental group in kindergarten.

On the basis of these results, the following observations and conclusions seem warranted:

(1) Children who had the science lessons tended to score higher on the reading readiness test. It is noteworthy, however,

that on the sub-test: matching, the control group scored significantly higher than the experimental group. This sub-test seems to measure skills that are closely related to some of the perception skills the science lessons were designed to enhance. It is possible that a systematic error in test administration contributed to this result.

(2) In terms of first grade reading achievement, the children who had kindergarten science programs appear to be doing disproportionately better than those children who did not have the science. It should be noted that the first grade teachers were not told why they were rank-ordering the children and were not aware of which children in their classes had had the science and which had not.

(3) In addition, several other observations related to the experimental program were noted. Teachers at both the Laboratory School and the Twelfth Street School reported gaining new insights into the abilities of children in their classes as a result of seeing the children work with concrete materials in a structured setting. The investigator noted subtle, but significant changes in the teaching styles of both teachers who used the science program during the course of the study. Procedures used in the science lessons were adopted to other materials and used in other parts of the kindergarten program.

Although the results of the reading readiness test were somewhat equivocal, trends toward higher scores by the experimental group were apparent. In addition the disproportionately higher achievement in first grade reading by experimental group children must be noted. A study involving a much larger population of inner-city children using the procedures and materials developed in the present study seems indicated by the results.

CHAPTER I

THE PROBLEM

Introduction

One of the most perplexing problems facing educators today is the apparent disparity in reading readiness between children from "advantaged" homes and children who come from "disadvantaged" backgrounds. It has been demonstrated that differences in reading achievement develop almost as soon as "advantaged" and "disadvantaged" children begin a reading program in school. In the case of the "disadvantaged" child an initial reading retardation is apparent. This retardation translates itself, in subsequent years, into a condition known as the cumulative-deficit phenomenon. That is, achievement patterns among so called advantaged and disadvantaged groups of children diverge so that by the eighth grade the average "disadvantaged" child has fallen three years behind in grade norms in reading (Bloom, 1965).

Many attempts have been made to isolate and study the factors that seem central in producing reading deficits among "disadvantaged" children (Deutsch, 1967; Hunt, 1961; Deutsch, 1963). One factor that appears over and over in these studies is the minimum range of visual stimuli available to urban slum children. Pictures, toys, furniture, and utensils tend to be sparse, repetitious, and lacking in color and form variation. The sparsity of objects and lack of diversity in home artifacts gives these children relatively few opportunities to manipulate, organize and discriminate the visual properties of their environment. The total effect of sparsity of manipulable objects on visual perception is not entirely known. It is known, however, that skills necessary for success in reading are based on such perception skills as form discrimination and visual-spatial organization. What's more, it is these visual perception skills that appear most often to be deficient in inner-city children (Deutsch in Passow, 1963).

In an attempt to assess the many-faceted problems of perceptual deficiencies, studies have been carried out to determine what effect, if any, instructional techniques and materials have on the perceptual skills of children. In general, it has been found that: (1) inner-city slum children who have perceptual training in kindergarten score higher on reading readiness tests than children who do not have the training (Faustman, 1966; McClanahan, 1967); (2) visual-motor perceptual skills are more closely related to reading achievement of "culturally deprived" children than are specific language skills (Weaver, 1967); and (3) science, taught in a non-bookish and intuitive manner seems to be an important way of developing perceptual skills in inner-city children (Giddings, 1966).

Consequently, instructional materials and techniques that provide opportunities for children to manipulate a wide variety of physical objects appear likely to contribute to the development of a variety of perceptual skills. These same materials and techniques appear equally fruitful for building conceptual and intellectual skills. In turn the development of these concepts and skills appears to be influential in building reading readiness and promoting later reading achievement.

Appropriately designed science-related experiences should lend themselves particularly well to the kinds of activities that appear most likely to influence reading readiness. That is, science experiences, consciously designed for and implemented in a kindergarten program should provide a child with multiple opportunities to manipulate a wide variety of materials; and it is these experiences that are believed best able to influence the development of basic conceptual and perceptual skills that result in subsequent improved readiness to read.

Two questions concerning the relationship between science experiences and reading readiness need answering at this time. First, which science experiences are both appropriate to the interests, needs and abilities of kindergarten children and fruitful of building the desired pre-reading skills? Second, what evidence can be produced to confirm or deny a causal relationship between science experiences and reading readiness? The following pilot study was undertaken in an attempt to answer these two questions.

Review of Literature

A review of the literature on reading readiness and initial reading achievement reveals two factors that appear to be the keys to a child's success or failure in reading. These factors are oral language fluency and visual and auditory perception--particularly visual discrimination. A closer look at each factor is most revealing.

Oral Language Fluency

The relationship between oral language and reading has been studied by number of researchers (Durken, 1966; Bormuth, 1968; Baratz, 1968; Goo , 1968). In general these studies confirmed the marked influence of skill in the use of oral language and success in reading and language arts. For example, a study by Feitelson showed that children's deficiencies in oral language manifested themselves in reading disability as soon as the school reading program was initiated (Feitelson, 1968). Both Labov and Giddings found that the kind, not the degree of oral fluency affected initial reading achievement (Labov, 1967; Giddings, 1966). They reported that lack of consonance between the oral and the printed language and problems in reading were highly related. That is, the greater the disparity between oral and written language the greater the severity of reading problems encountered by children.

Perceptual Skills

Research findings also indicated that perceptual skills such as visual discrimination played an important role in reading achievement. Shumard found that reading difficulties were directly related to problems of visual perception (Shumard, 1968). The most common of the perceptual problems included lack of visual-motor coordination, poor figure-ground perception, and the inability to perceive spatial relationships. King, in discussing the factors that played the major role in formal reading achievement, stressed the importance of the child's ability to see letter differences in printed words (King, 1969). This ability was, in turn, based on a more fundamental skill--that of discriminating shape, size, spatial relationships, and arrangements of visual details. Cohen reported on the role of visual perception in a child's ability to discriminate letters (Cohen, 1967). He called this ability the prime prerequisite of reading. Scott found a direct relationship between young children's perceptual skills and later success in reading (Scott, 1968). Faustman and McClanahan reported that children who had perceptual training scored higher on reading readiness tests than children who had no such training (Faustman, 1966; McClanahan, 1967).

Relationship of Socio-Economic Status & Basic Reading Skills

Inner-city children were reported to have deficits in both verbal fluency and skills of visual and auditory perception. Results of a study of the oral language patterns of low socio-economic groups revealed that children from sub-middle-class backgrounds brought a distinct set of language patterns to the school setting. Furthermore, these distinct language patterns were found to interfere with the subsequent reading process, which was based on an entirely different set of patterns--those of middle-class America (Mortenson, 1968). Both Bernstein and Deutsch reported similar findings. Bernstein found that disparities in the syntax and the degree of elaborateness of language coding among children from the various socio-economic groups were key problems in reading (Bernstein, 1964). Deutsch noted that reading materials, in general, were not designed to take oral language variations into consideration (Deutsch, 1963). As a result, many children were unable to derive meaning from the materials they were given to read. For these children reading became a meaningless, mechanical, and frustrating exercise in futility.

Barbe found that children from backgrounds in which the opportunity to develop oral language skills was limited were placed in a position of great disadvantage when they entered school (Barbe, 1968). The disadvantage was most keenly observed in the area of reading. Feitelson, reporting on disadvantaged Israeli children, found that these children were deficient both in oral language experience and in the development of adequate motor skills such as hand-eye coordination. It was suggested that culturally disadvantaged children often lacked play and work materials such as crayons, scissors, paste, play-dough, and mechanical toys. The paucity of such materials was linked directly to deficits in percep-

tual and motor skills (Feitelson, 1968). An almost identical finding was reported by Deutsch (Deutsch, 1965). In another study Silberman reported that children from America slum areas were generally deprived of sense-stimulating materials such as blocks, bells, and touch boards. As a result these children were deprived of certain facets of the perceptual and conceptual growth that is typical of middle-class children (Silberman, 1964). In addition, Bloom, Davis, and Hess found that the development of perceptual skills was stimulated by "environments which are rich in the range of experiences; which make use of games, toys, and many objects for manipulation" (Bloom, Davis, and Hess, 1965).

Thus, the problem of why inner-city children display proportionately higher incidents of reading problems seems clearly documented. Reading is closely dependent on oral fluency and well developed perceptual skills. The typical inner-city child brings with him to the formal reading experience a deficit in both of these areas.

Steps Taken to Improve Reading Readiness of Inner-City Children

Compensatory pre-school and kindergarten programs have burgeoned over the past five years. Bereiter and Englemann have carried out a massive program to change language habits in pre-school children (Bereiter and Englemann, 1967). Harvey carried out a program designed to increase oral fluency and reading readiness through the use of large flash cards on a popular morning children's television program (Harvey, 1968). Moore's talking typewriter was another attempt to help children develop verbal facility (Moore and Anderson, 1968).

However, while considerable effort was put forth in recent years to provide enrichment and compensation in the area of oral fluency, far less work has been undertaken in the area of perceptual skill development. Scott pointed out that pre-reading compensatory programs concentrated largely on the oral language aspects of reading to the partial or total exclusion of visual or perceptual learning (Scott, 1968). Tyler found that deficiences in perceptual skills were the key elements in the reading problems experienced by large numbers of inner-city children (Tyler, 1956). Hunt, in fact, suggested that perceptual experiences were needed by children in order that their central processes (which control language activities) develop neurologically (Hunt, 1961).

As a first step in providing some compensatory experiences in the area of perception, Bloom, Davis, and Hess proposed that nursery schools and kindergartens for inner-city children be organized to provide the perceptual stimulation found in the "most favorable home environments" (Bloom, Davis, and Hess, 1965). Witty described the characteristics of superior home environments in the following terms: they provided a) opportunities for rich and varied sensory-motor activities; b) freedom to explore the environment; and c) abundant variety of experiences (Witty, 1968).

Attempts to remedy a variety of visual perceptual problems were made in programs developed by Marianne Frostig and David Horne and by

Florence Sutphin. The first of these programs, the Frostig Program for the Development of Visual Perception, consisted of a series of activities such as tracing, drawing without guidelines, coloring, and other similar visual perception tasks. The Sutphin program was somewhat less formal than the Frostig program in the sequencing and carrying out of activities. The basic objectives of the two programs were similar, however; the development of visual perceptual skills such as visual-motor coordination, figure-ground perceptions, and the ability to perceive spatial relationships.

It cannot be denied that inner-city children are exposed to a variety of experiences. However, it appears that inner-city children do not sense the variety of perceptual experiences that are closely related to reading success. Furthermore, relatively little is being done by curriculum planners and teachers of the various pre-school, kindergarten, and early primary programs to provide meaningful and sufficient numbers of specific perceptual experiences for the children who most need them.

<u>What Role Can Science Play in Developing Reading Skills?</u>

It has been demonstrated that the development of perceptual skills is one of the two fundamental processes that serve as the cornerstones of success in reading. In a study designed to predict success in reading, Weaver found that visual-motor skills were more closely related to reading achievement--particularly with culturally deprived children--than were specific language skills (Weaver, 1967). Bloom pointed out that a variety of materials were needed to help children learn in a variety of ways in order to develop perceptual skills (Bloom, 1966). Almy conducted a study designed to inquire into the thinking of young children. One of the chief findings was the following:

> The point to be made for those who would construct curriculum is that in the early childhood period activity and language need close association. For example, in the case of the socially disadvantaged child, no adequate comparison of quantities can be made by a child who does not understand the terms "more" and "less", or "most" and "least". But comprehension of those terms may not be developed through words alone, or even associations of words and picture, but rather through a combination of manipulation and verbalization (Almy, 1966).

Krippner, commenting on a pre-reading program for disadvantaged pre-schoolers pointed out that:

> A traditional nursery program which emphasized personal, social, and general motor development was found to be inferior to a highly structured program which utilized manipulative objects, multi-sensory materials, immediate verbal responses, and the development of highly specific learning abilities (Krippner, 1968).

In the school curriculum there is probably no discipline better suited to providing the child with quantities of both structured and unstructured multi-sensory manipulative materials than science. In recent years a number of science programs have been developed that emphasize the use of manipulative equipment as the primary learning tool. Science - A Process Approach, The Science Curriculum Improvement Study, and the Elementary Science Study are three such programs commercially available at the kindergarten and/or first grade level. Each of the three programs present materials and methods that are designed to provide children with experiences that increase a child's sensitivity to his surroundings by stimulating all of the senses. Direct observation of similarities and differences among a variety of objects is a specific goal in each of the programs. Materials used in the programs are designed to provide multi-sensory, first hand experiences for young children.

Some research has been carried out to try to assess the impact of selected science experiences on the reading readiness of children. Newport reported:

> Some of the new science programs hold considerable promise for promoting development necessary for reading. Since the programs are oriented toward 'providing children with experiences in science' instead of toward the traditional approach of 'teaching science content to children', the programs should help children become intellectually ready to read. In addition, since many of the activities are to be conducted in settings that should result in much verbal expression, the programs should also contribute toward making children language ready for reading (Newport, 1969).

Rowe reported that spontaneous language during science classes exceeded that in language arts classes by 200 per cent (Rowe, 1968).

Ayers and Mason studied the influence of a specific science program, Science - A Process Approach, on reading readiness. They found that children who were instructed by means of the process approach materials scored significantly higher on Number, Listening, and Copying sub-tests of the Metropolitan Reading Readiness Test than did a group of similar children who did not have the experimental program. Discrimination, categorization, and labeling tasks in the program apparently contributed to a child's success on the readiness test (Ayers and Mason, 1969).

Giddings pointed out the potential benefits of early science experiences for all children. He built an extremely strong argument for providing science experiences for inner-city children. It was suggested that because science can be readily taught in an intuitive, non-bookish way, it can be used as a tool for introducing reading. He stated:

> Because of the scientific-technological dimension of our modern society and the respect for disadvantaged already

have for science, the area of science education may be used effectively as the vehicle to motivate all youngsters in other academic areas as well as in science (Giddings, 1966).

Therefore, as one considers the evidence concerning the reading difficulties experienced by a disproportionately large number of inner-city children, the following statements seem justified:

1. The two key factors involved in reading success are oral fluency and visual and auditory perception.

2. Inner-city children are frequently found to be deficient in both oral fluency and perceptual skills.

3. Steps have been taken to provide compensatory training in the area of oral fluency.

4. Less has been done to provide inner-city ch!'dren with compensatory training in the area of visual perceptual deficiency.

5. Visual perceptual skills believed to be closely related to reading skills are discrimination of shape, size, and spatial relationships, development of figure-ground perceptions, and the ability to perceive spatial relationships. These skills are best developed through direct sensory experiences with a variety of objects and a variety of contexts.

6. Science is an area of the pre-school and kindergarten program which lends itself well to providing children with opportunities to manipulate large quantities of both structured and unstructured multi-sensory materials. Thus, science is an activity that promotes visual perceptual skills. Furthermore, science lends itself well to concept development in areas of high interest to children. Finally, science can be useful as a vehicle for vocabulary and oral language development.

On the basis of the literature reviewed it seems apparent that skills useful in promoting success in reading can be developed through the use of selected science activities. In addition, it appears that these science activities can be most beneficial to children who need some sort of compensatory program in the area of visual perceptual skills.

Objectives, Hypotheses and Limitations

Because this was a pilot study, the objectives of the study were, to an extent, related primarily to qualitative evaluations of the effectiveness of materials and techniques used in day-to-day science lessons and equally qualitative judgments of the effects of these science lessons on teachers and children using them. Feedback was gained by personal

interviews and observations by the investigator, two assistants, and the two teachers using the materials. Additional qualitative data were obtained from first grade teachers--not involved in any way with the science program--but present teachers of children who had received the science program.

Quantitative data were obtained from the results of a test of reading readiness given to children who had the science program. These children were compared to a group of children who did not have the science program.

The specific objectives of the study were as follows:

a. To investigate the appropriateness of a variety of science-oriented materials for use with kindergarten age children.

b. To evaluate the usefulness of various procedures for carrying out science lessons using the materials.

c. To assess the influence of the materials and procedures on a child's ability to make auditory, visual, and tactual discriminations.

d. To compare scores on a test of reading readiness of children who had the science experiences and children who did not have these experiences. With regard to this aspect of the study the following hypotheses were tested in an attempt to determine what influence, if any, kindergarten science experiences had on reading readiness scores:

   1. There are no differences between children who have kindergarten science experiences and children who do not have the experiences on a sub-test of reading readiness: vocabulary.

      $(H_{0_1}: V_E = V_C)$

   2. There are no differences between children who have kindergarten science experiences and children who do not have the experiences on a sub-test of reading readiness: listening.

      $(H_{0_2} : L_E = L_C)$

   3. There are no differences between children who have kindergarten science experiences and children who do not have the experiences on a test of reading readiness: matching.

      $(H_{0_3} : M_E = M_C)$

   4. There are no differences between children who have kindergarten science experiences and children who do not have the experiences on a test of reading readiness: alphabet.

      $(H_{0_4} : A_E = A_C)$

5. There are no differences between children who have kindergarten science experiences and children who do not have the experiences on a test of reading readiness: numbers.

$(H_{O5} : N_E = N_C)$

6. There are no differences between children who have kindergarten science experiences and children who do not have the experiences on a test of reading readiness: copying.

$(H_{O6} : C_E = C_C)$

7. There are no differences between children who have kindergarten science experiences and children who do not have the experiences on the total score of a reading readiness test.

$(H_{O7} : T_E = T_C)$

e. To qualitatively assess the reading achievement in first grade of children who had the science experiences in kindergarten.

Because of the need to evaluate much of what was done in the study in qualitative rather than quantitative terms, one need recognize the limitations of such assessments. The changes made in lesson content and structure were based on the professional judgments of the classroom teachers and the investigator and represent, in some cases, personal biases or limited experience. Likewise, because of the relatively small sampling of students used in the study, the responses of a small number of children on end-of-lesson evaluations and on the reading readiness test had profound effects on the reported results. The small sampling of teachers must also be recognized as a limitation. In a study such as this, it is extremely difficult to control for experiences a child has outside the school curriculum or in other areas of the kindergarten curriculum. It must be assumed that, except for science, the school experiences of the experimental and control groups were relatively equivalent. Neither group was exposed to any other experimental kindergarten program and all teachers involved, both experimental and control, were certified and tenured teachers.

CHAPTER II

METHODS

This chapter describes the population, procedures, and methods of collecting and analyzing data that were employed in carrying out the pilot study designed to investigate influences of science experiences on reading readiness.

The Population

The population for the study consisted in reality of three separate populations, each selected for the purpose of assessing different aspects of the investigation.

1. The only kindergarten class at the University of Wisconsin-Milwaukee Laboratory School made up one group of children in the study. This class was made up of twenty-one children, nine of whom were brought from an inner-city neighborhood to the campus daily. The other twelve youngsters were children of faculty members. Children ranged in age from five years and two months to six years and one month, as of January 1, 1969. Eleven of the children were girls and ten were boys. This group was used to try out materials and procedures.

2. The morning kindergarten class at the Twelfth Street School was selected as the experimental group in the study. This was the only kindergarten class meeting in the morning in the school. It was made up of twenty-four inner-city children ranging in age from five years and three months to seven years and one month, as of January 1, 1969. There were thirteen girls and eleven boys in the group at the start of the study. During the course of the investigation two girls and two boys left the class.

3. The control group for the study was selected on the basis of two predetermined criteria. First, children were chosen from the school nearest to the Twelfth Street School. The Hopkins Street School is located approximately three blocks north and west of the Twelfth Street School. Second, children were chosen on the basis of similarity of IQs to children in the experimental group. That is, children in the control group were matched in terms of scores earned on the Pintner-Cunningham Intelligence Test (Form A) to children in the experimental group. The children in the control group ranged in age from five years and three months to six years

and nine months, as of January 1, 1969. There were nine girls and eleven boys in the control group.

Procedures

Approximately three months before the initiation of the study a series of science lesson plans were prepared and written out by the investigator. Two factors guided the preparation of all lessons. First, each lesson was designed in such a way that a child would be given his or her own materials with which to work. Second, each lesson was designed to provide each child with an opportunity to observe materials that were similar in some ways and dissimilar in others. After observing and manipulating the materials provided for each lesson or activity, children were asked to make similar observations or answer questions related to two dimensional representations, usually pictures or drawings, of the same objects as those used in the lesson. In other words the child first experienced materials directly (concretely) and then moved to two dimensional abstractions of the same objects. This phase of the lesson was usually included in or made up the lesson evaluation. As a result, in the process of performing an operation or examining the objects given him, the child would have to discriminate among the objects or their properties. He would then make similar discriminations involving drawings of the objects. In some cases, the discriminations were visual, in other cases auditory, and in several instances tactual. At the same time, the following concepts were being developed as an integral part of the series of lessons:

1. Some objects are alike. Some are different.

2. The names of colors are red, blue, yellow, green, purple, orange, brown, and black. Each child should be able to identify these colors.

3. The names of some shapes are rectangle, square, circle, and triangle.

4. Matter is anything that takes up space or has weight.

5. All matter is made up of properties.

6. Matter is made up of solids, liquids, and gases.

In all cases the primary goals of the lessons were related to the discrimination skills and the secondary goals to the comprehension of concepts of matter.

Each lesson plan consisted of (1) objectives; (2) suggested procedures; and (3) a suggested evaluation. The entire series of lesson plans was prefaced by a note to teachers and an overview of the entire program. The lessons are included in Appendix I.

It should be noted that ideas for some of the lessons were based on procedures included in the Science - A Process Approach elementary science program and The Science Curriculum Improvement Study. In all cases the emphasis of the lessons and the materials were modified to meet the needs of the present study.

As an initial step in evaluating the lessons all lesson plans were typed, duplicated, and distributed to four primary teachers at the UWM Laboratory School. Each teacher was asked to respond to each lesson in terms of the following criteria: a) Based on your experience is this lesson teachable? b) Do you feel that this lesson is at a reasonable difficulty level for a kindergarten child? and c) Do you believe a high level of interest could be maintained throughout this lesson?

On the basis of the responses received from the teachers, a number of minor changes were made in the procedures or types of materials to be used. In one instance two lessons were dropped in their entirety from the series.

After a consensus was reached concerning the lessons to be used, sufficient materials for classes of thirty children were purchased or made up by the investigator. Two assistants were hired at this time and helped in the preparation of materials. In all cases materials were placed in small packages and then boxed in color-coded and clearly marked containers.

One month before lessons were initiated, the investigator met with the principal and the kindergarten teacher at both the UWM Laboratory School and the Twelfth Street School. The project was described and teachers were asked to participate. In both cases the teachers volunteered to become associated with the investigation. Two weeks before lessons were initiated, both teachers were given two two-hour briefing sessions in which an overview of the project and a description of the individual lessons were given by the investigator. It was agreed that meetings between the investigator and the teachers would be held bi-weekly once the program commenced. Each teacher was assigned an assistant from the project whose job it was to insure that all materials were on hand and ready for use at each lesson, to assist the classroom teacher in carrying out the lessons, and to prepare daily evaluations of the progress and success of the lessons. Both of the assistants were teachers who were studying towards Master's Degrees at UWM.

In carrying out the lessons, a predetermined general procedure was followed throughout the investigation. Each lesson was presented to the kindergarten class at the Laboratory School as outlined in the teacher's booklet. Both the classroom teacher and the project assistant kept careful notes on the success of the lesson. Success was evaluated in terms of a) ability of the children to carry out the tasks expected of them; b) interest level of the group throughout the various activities included in a lesson; c) achievement of the goals of the lesson by the children; d) the number of children who would not or could not participate in the activity(ies).

At the bi-weekly meetings of the staff, each lesson was discussed in detail by the entire staff. Changes in lessons already carried out were made as indicated. Pitfalls were pointed out. Then lessons to be carried out during the next two week period were described.

Two weeks after lessons were conducted at the Laboratory School and, in all cases, following the staff evaluation meeting, the same lessons (with necessary changes) were carried out in the experimental class at the Twelfth Street School. The first of the lessons was initiated on February 3, 1969 at the Laboratory School. The same lesson was presented at the Twelfth Street School on February 17, 1969.

The following are the titles of the various units and lessons included in the program:

<u>Unit I</u> - Observing and Classifying a Variety of Objects

Lesson 1 - Collecting and observing objects around the school.

Lesson 2 - Observing seeds and plants.

Lesson 3 - Observing, naming, and identifying colors.

Lesson 4 - Naming and identifying two dimensional shapes.

Lesson 5 - Classifying buttons.

<u>Unit II</u> - Defining Matter and Properties of Matter

Lesson 6 - Defining matter.

Lesson 7 - Comparing properties.

Lesson 8 - Experiences with solids.

Lesson 9 - Experiences with liquids.

Lesson 10 - Experiences with gases.

<u>Unit III</u> - Using Quantitative Measures in Observing Matter

Lesson 11 - Developing the concept of serial order.

Lesson 12 - Developing the concept of rough and smooth.

<u>Unit IV</u> - Experimenting with Matter

Lesson 13 - Comparing halite, rock salt, and crystal salt.

Lesson 14 - Observing ice and water.

Lesson 15 - Experimenting with gases.

All lessons were completed by early June, 1969. Quantitative data on the reading readiness of the experimental and the control group were collected in September, 1969 when the Milwaukee Public Schools administered the Metropolitan Reading Readiness Test, Form A, to all first grade children in the school system.

Follow-up

A second trial of the lessons at the Twelfth Street School was carried out during the Fall semester 1969-70. This trial was carried out in two kindergarten classrooms simultaneously. Less staff supervision was provided for this trial in an attempt to assess the ability of teachers to use the materials "on their own" and to evaluate additional changes in lessons that were made following the first trial. One of the teachers involved in this trial had taught the lessons during the previous Spring. The other teacher was new to the program. One staff assistant was provided to maintain equipment and observe and evaluate lessons as they were being taught. Bi-weekly meetings were held throughout this second trial of the series of science experiences. Only qualitative data regarding the teachability of lessons were collected during this second trial.

Collection and Analysis of Data

Data collected in this study were of two types: qualitative and quantitative.

Qualitative Data

Qualitative data were collected by various members of the research staff throughout the course of the investigation. Daily logs and records of achievement were kept by the assistants in both the Laboratory School class and the Twelfth Street School class. In addition, daily logs were kept by the classroom teachers and twice weekly observations were made by the principal investigator. All information was discussed and evaluated at the bi-weekly meetings and a bi-weekly report was prepared. It was on the basis of these reports that changes in materials and procedures used in various lessons were made.

Qualitative data on the achievement of individual children in the two classes were kept on a prepared check-off form. For each lesson eight children were selected and evaluated by the teacher using the procedures suggested in the lesson plans. These evaluations were carried out with individual children and records kept on a child's apparent achievement of goals of the lessons. In general, a child was formally evaluated for every second or third lesson. Because of the structure of the lessons, the teachers and the aides were able to walk among the children in the

classes as they were working with the materials. In this way, an informal evaluation of procedures and goals was also accomplished for each lesson.

An attempt was made to determine the present level of reading competence of children who had participated in the science program during the previous semester. The children had been assigned to one of two first grade classes on the basis of anticipated achievement in first grade. Approximately one-half of the children who had been in the kindergarten science program were assigned to a transition class. These children were believed to be lower achievers. The other half of the experimental group was assigned to a "regular" first grade class. During the third week of January, 1970, both the transitional group teacher and the first grade teacher were asked to rank-order their children in terms of overall reading achievement. The best reader was to appear at the top of the list and the least able at the bottom. Both teachers were mature and experienced women and had taught in inner-city schools for a minimum of two years.

Quantitative Data

The Metropolitan Reading Readiness Test (Form A) was administered to the children of the experimental and control groups during the third week of September, 1969. The tests were administered by the classroom teacher. The investigator was not present when the tests were administered. The tests were scored by school testing personnel at the central office of the Milwaukee Public Schools and the data were made available to the investigator in January, 1970.

Analysis of Data

Qualitative data were evaluated by the total staff involved in the study. Decisions and conclusions were, in general, arrived at by consensus or mutual agreement. Quantitative data were analyzed by means of a one-way analysis of variance using the University of Wisconsin Computing Center Program One Way 1. Seven variables consisting of six sub-test scores and one total score were analyzed for significance.

Because this was a pilot test, it was decided by the investigator that a somewhat less rigorous level of significance would be used in analyzing the data. As a result, a probability level of $p < .10$ was used.

CHAPTER III

FINDINGS AND ANALYSIS

This section will be divided into two parts. One part will deal with qualitative findings--those things observed by the research staff consisting of the principal investigator, two assistants, and two kindergarten classroom teachers. In addition, the reports of two first grade teachers on the reading achievement of children who had the science program will be included. The other part of this section will include the quantitative data obtained from the results of the Metropolitan Reading Readiness Test, Form A.

Qualitative Results

1. Lessons and Materials

On the basis of teacher responses to an initial reading and evaluation of lessons, it was decided that two lessons that had originally been included in the program were too complex for kindergarten children and were dropped entirely. All other lessons were retained, some with minor modifications. Following the try-out at the UWM Laboratory School, each lesson was carefully evaluated by the staff for teachability, interest for child, appropriateness to child's abilities, and usefulness in helping a child achieve the predetermined goals. It was decided that a) lessons one through twelve be made the basic science program and lessons thirteen through fifteen be made optional (these three lessons would be used at the teacher's discretion with children who needed or would benefit from the more complex lessons) and b) evaluations would be individualized and a random sampling of children would be evaluated in each lesson. It was found that group evaluations with kindergarten children were meaningless since most of the children prefered to "share" answers. Table 1 summarizes the qualitative decisions made on each lesson following the Laboratory School try-out (see Table 1, pp. 20-22).

Changes deemed essential to the success of the program were made after the Laboratory School trial and the lessons were presented to the morning kindergarten class at the Twelfth Street School. The following results were noted:

1. Interest and achievement levels of the children matched those of the children in the Laboratory School on all lessons except lesson eleven where unusual difficulty in using the symbols for "greater than" and "less than" was encountered.

TABLE 1

SUMMARY OF FINDINGS OF TEACHERS AT UWM LABORATORY SCHOOL ON TRY-OUT OF PROCEDURES AND MATERIALS

Lesson	Topic	General findings reported by teachers and assistant
1	Observing a variety of objects	The school grounds provide a place to pick up objects. Avoid glass and other dangerous materials often found in school area. Have a table on which a variety of objects is available [illegible] the classroom for those who fail to find materials on the playground.
2	Observing plants	Use petrie dishes and keep those plants that are germinating well watered. Children enjoyed this lesson and were able to describe their observations and achieve goals.
3	Colors	Use plastic rather than paper bags for materials. Interest was high throughout the entire lesson. Good variety of activities.
4	Shapes	Best lesson so far. Children like the word rectangle. Good participation by all children.
5	Sorting buttons & tiles	Easy for children. Several were able to sort by multiple properties including one boy who had been almost non-verbal up to this time. Very successful lesson.
6	Defining matter	Very difficult for some children. Quite a bit of teacher-centered activity. Lesson required several repetitions. Difficult to assess whether children are parroting teacher's verbalizations or understand concepts being taught.

TABLE 1--Continued

Lesson	Topic	General findings reported by teacher and assistant
7	Defining properties	Major changes made in this lesson. It was actually broken into three sub-lessons each dealing with a comparison of objects made up of opposing properties, e.g. soft and hard, warm and cold. Many examples needed in order to elicit evidence of a child's understanding of the concept.
8	Experiences with solids	Good series of activities. Children particularly enjoyed comparing the wood, wood chips, and sawdust using magnifying glass. Evaluation was difficult and results were believed spurious.
9	Experiences with liquids	"Messing around" activity was very successful. Mixing of colors in hot and cold water was best demonstration so far. High interest throughout this activity.
10	Experiences with gases	Most children were able to identify apple in bag. Excitement of using party whistles was good. Iodine crystal demonstration went very well--children were very interested and were able to observe and discuss differences: similarly with CO_2 demonstration. Spray deodorant experiment didn't work well because children couldn't stand still and misinterpreted sensory data. Evaluation was good.
11	Serial ordering objects	Began with review of lesson #7. Dowels and corks were easily ordered. Shapes were not easily ordered. Use of symbols required many repetitions. Only about half of the class seemed able to use the symbols.

TABLE 1--Continued

Lesson	Topic	General findings reported by teacher and assistant
12	Serial ordering objects on basis of roughness & smoothness	High interest. More children now seem able to discuss greater than and less than and most children are now able to use the symbols accurately.
13	Comparing halite, salt pellets, & granulated table salt	The activities of the lesson were relatively easy for most children. The evaluation activities were difficult for almost all of the children.
14	Observing ice & water	This lesson proved hectic for teacher and pupils. Children were able to make required observations under careful supervision of the teacher. Interpretation of the data was difficult. Very heavy on teacher involvement.
15	Experimenting with gases	All children enjoyed "messing around" with syringes. Only a few were able to discuss observations or achieve stated goal of the lesson.

2. Difficulties in assessing children's achievement on individual lessons were greatly reduced by the use of random selection of individual children for the purpose of determining concept achievement. Each child was assessed formally on every second or third lesson and informally on almost every lesson by the teacher or the project assistant.

3. The teacher at Twelfth Street School reported gaining new insights into the relative abilities of three out of twenty-four children in her class as a result of their high level of achievement on the science lessons. In particular, one girl who had been earmarked for retention in kindergarten proved to be a high achiever in the science and was promoted to first grade.

4. On the basis of teacher and project assistant judgment, the numbers of children who attained the predetermined goals of each of the lessons, three through twelve, were recorded. Seventy-six per cent of the responses were deemed indicative of goal achievement. These numbers appear in Table 2.

5. The two first grade teachers at the Twelfth Street School were asked to rank-order their classes in terms of present over-all reading achievement during the third week of January, 1970. In one of the classes eight out of ten children deemed the "best" readers in the class by the teacher had come from the kindergarten class that had the science lessons. In the other class eleven out of the "top" thirteen readers had come from the science class.

Quantitative Results

It had been determined that a major consideration in evaluating the effects of the science lessons on inner-city children would be the scores of these children on a reading readiness test. For the purpose of measuring reading readiness, the Metropolitan Reading Readiness, Form A, was used. This was the test regularly used by the Milwaukee public schools. Furthermore, in order to conform to Milwaukee public school policies, reading readiness testing done on children outside of the Twelfth Street School was administered by the regular first grade teacher during the third week of September. Thus, testing of both the experimental and the control groups was postponed until September, 1970. Tests were scored by public school personnel and scores then made available to the investigator. The scores included six sub-test scores and one total score for each child.

These data were then analyzed for significance using a one-way analysis of variance model. Raw data are included in Appendix II. Sub-test and total test analyses of the data are given in Tables 3-10.

TABLE 2

NUMBER OF CHILDREN WHO ACHIEVED THE STATED OBJECTIVES IN EACH OF TEN SCIENCE LESSONS. EIGHT CHILDREN WERE SELECTED BY THE TEACHER FOR EVALUATION IN EACH LESSON

Lesson	Number of children who achieved goals*	Number of children who did not achieve goals*
3	7	1
4	6	2
5	7	1
6	4	4
7	5	3
8	6	2
9	7	1
10	7	1
11	5	3
12	7	1
Total	61	19

* as perceived by the teacher

TABLE 3

MEANS AND STANDARD DEVIATIONS OF SIX SUB-TESTS AND TOTAL SCORE OF EXPERIMENTAL AND CONTROL GROUPS ON METROPOLITAN READING READINESS TEST*

		Sub-test Vocabulary	Sub-test Listening	Sub-test Matching	Sub-test Alphabet	Sub-test Numbers	Sub-test Copying	Total
Experimental	Mean	10.45	9.95	7.15	11.15	11.15	4.35	54.20
Group	S.D.	2.13	2.26	3.66	3.91	4.87	2.78	15.56
Control	Mean	6.85	9.30	9.25	8.70	7.45	4.65	46 20
Group	S.D.	2.47	1.52	2.71	4.21	4.14	2.23	11.91

* N - 40

TABLE 4

ONE WAY ANALYSIS OF VARIANCE ON DATA OF SUB-TEST: VOCABULARY
METROPOLITAN READING READINESS TEST

Source	Sums of Squares	Mean Squares	Df	F-Ratio
Between Groups	129.599	129.599	1	24.20[A]
Within Groups	203.500	5.355	38	

[A] Significant beyond .001

TABLE 5

ONE WAY ANALYSIS OF VARIANCE ON DATA OF SUB-TEST: LISTENING
METROPOLITAN READING READINESS TEST

Source	Sums of Squares	Mean Squares	Df	F-Ratio
Between Groups	4.224	4.224	1	1.137
Within Groups	141.150	3.714	38	

TABLE 6

ONE WAY ANALYSIS OF VARIANCE ON DATA OF SUB-TEST: MATCHING
METROPOLITAN READING READINESS TEST

Source	Sums of Squares	Mean Squares	Df	F-Ratio
Between Groups	44.100	44.100	1	4.250[B]
Within Groups	394.300	10.373	38	

[B] Significance level of .046

TABLE 7

ONE WAY ANALYSIS OF VARIANCE ON DATA OF SUB-TEST: ALPHABET
METROPOLITAN READING READINESS TEST

Source	Sums of Squares	Mean Squares	Df	F-Ratio
Between Groups	60.024	60.024	1	3.628[C]
Within Groups	628.750	16.546	38	

[C] Significance level of .064

TABLE 8

ONE WAY ANALYSIS OF VARIANCE ON DATA OF SUB-TEST: NUMBERS
METROPOLITAN READING READINESS TEST

Source	Sums of Squares	Mean Squares	Df	F-Ratio
Between Groups	136.899	136.899	1	6.691[D]
Within Groups	777.500	20.460	38	

[D] Significance level .014

TABLE 9

ONE WAY ANALYSIS OF VARIANCE ON DATA OF SUB-TEST: COPYING
METROPOLITAN READING READINESS TEST

Source	Sums of Squares	Mean Squares	Df	F-Ratio
Between Groups	0.899	0.899	1	0.142
Within Groups	241.110	6.344	38	

TABLE 10

ONE WAY ANALYSIS OF VARIANCE ON DATA OF TOTAL SCORE
METROPOLITAN READING READINESS TEST

Source	Sums of Squares	Mean Squares	Df	F-Ratio
Between Groups	639.998	639.998	1	3.333[E]
Within Groups	7296.400	192.010	38	

[E] Significance level of .076

Analysis of Findings

In analyzing the findings of this study, one must again recognize that some of the data were of a qualitative nature while others were quantitative in nature. It is the sincere belief of the principal investigator that all reported findings represent a totally honest appraisal of the quality of the various lessons and the value of the science experiences to the children involved. Every attempt was made to be as objective as possible and to withhold judgements until all the facts were available. However, it cannot be denied that qualitative findings reported in this study were influenced by beliefs and opinions as well as the observations and inferences of the staff.

With regard to specific findings in the study:

1. The teachability of the lessons was enhanced by the close cooperation of the research staff with the school staff. The classroom teachers received both moral support and technical assistance which not only influenced their desire to teach the lessons, but probably had a halo effect on all aspects of the program.

2. Because of the small sampling of teachers and pupils in the study, there was no way to control for the Hawthorne Effect. This effect, therefore, cannot be evaluated, but likewise cannot be ignored.

3. Positive findings regarding the children's success in their first grade reading program may be the result of tangential benefits accrued from the science program as much as from the direct benefits of specific content of lessons. There is little doubt in the mind of the investigator that the teachers who used the science materials gained new insights into the skills and abilities of many apparently "slow" children in their classes. But it seems of almost equal significance that the teachers gained insights into the general use of materials with children as a result of teaching the science lessons. The style of lessons used in the science program was implemented somewhat unconsciously by the teachers into other aspects of their school program. Without apparent conscious motivation, each teacher was observed by the investigator to institute new, subtle activities into their daily schedule during the course of the study. In one case children were given large quantities of mathematics-related materials in order to develop number concepts. The teacher stated that she felt that manipulating quantities of materials rather than rote counting and recognition of numerals would result in better understanding by the children. In other words, the teaching styles of the teachers involved in the study were apparently affected by the experiences with the science lessons.

It may be that the changes in teaching styles were as much or more responsible for positive results noted than was the content of the lessons taught.

4. Quantitative results on the reading readiness test were greatly influenced by the small number of children in the populations used. One or two highly deviant scores were observed to have profound effects on the over-all results. In addition, close inspection of the scores of children in the experimental group on sub-test 3: matching, seems to indicate some systematic error in test administration in one of the two classes. Five of the ten children in that class scored from five to ten points lower on that sub-test than they did on any of the other sub-tests (with the exception of sub-test 6: copying, on which all children seemed to score uniformly low). Two children scored zero. It must be pointed out that great emphasis was placed on developing visual discrimination throughout the course of the science lessons. The sub-test of matching would appear to be the most directly related of the sub-tests to visual discrimination. Yet, it was on this sub-test and only on this sub-test that the control group did significantly better than the experimental group.

5. The only feedback on the reading achievement in first grade of children who had science in kindergarten was a subjective report by the present first grade teachers. It should be noted, however, that experts in tests and measurements consider subjective reports of teachers regarding children's achievement as valid and reliable as the results obtained from the best achievement tests.

CHAPTER IV

CONCLUSIONS AND RECOMMENDATIONS

In this chapter the final results of the present study are enumerated and general conclusions and recommendations are given.

Objectives and Hypotheses Tested

On the basis of objectives, both qualitative and quantitative, investigated in the study, the following specific results are noted:

1. The variety of science-oriented materials employed in this study were appropriate for use with kindergarten-age children.

2. The procedures used to carry out the science lessons were appropriate for kindergarten-age children.

3. Children displayed a high level of achievement with regard to auditory, visual, and/or tactual discriminations in the lessons tested in the study.

4. On the test of reading readiness:

   a. Children in the experimental group scored significantly higher ($p < .001$) than children in the control group on the reading readiness sub-test: vocabulary.

   b. There were no differences between children in the experimental and control groups on the reading readiness sub-test: listening.

   c. Children in the control group scored significantly higher ($p = .05$) than children in the experimental group on the reading readiness sub-test: matching.

   d. Children in the experimental group scored significantly higher ($p = .064$) than children in the control group on the reading readiness sub-test: alphabet.

   e. Children in the experimental group scored significantly higher ($p = .014$) than children in the control group on the reading readiness sub-test: numbers.

f. There were no differences between children in the experimental and control groups on the reading readiness sub-test: copying.

g. Children in the experimental group scored significantly higher ($p = .076$) than children in the control group on the total score of the reading readiness test.

5. The reading achievement of first grade children who had the science experiences in kindergarten appeared considerably greater than would be expected by chance occurence when they were compared to other children in their classes who had not had the science experiences in kindergarten.

General Conclusions

It would appear, from the results of this study, that specific science experiences in kindergarten were both teachable and fruitful of influencing a child's readiness to read. The degree of influence and specific ways in which the lessons manifested an influence in a child could not be ascertained in this study.

Recommendations

In order that more definitive findings be produced from a study such as this, a much larger population must be used to measure reading readiness and subsequent reading achievement. In addition, reading achievement should be validated by a standardized test to reinforce the first grade teacher's observations.

There is little doubt in anyone's mind that reading is the key to school success. For many children that "key" is never altered to fit their particular "lock". Science lessons, such as those designed for and implemented in this study appear to influence children in a number of ways. First, there appears to be an increase in vocabulary and alphabet recognition and an increase in number concepts. Second, there appears to be some carry-over from the kindergarten program into the first grade reading program. Specifically how or why this occurs is only speculative at this time. Indications are, however, that a broader based study involving many teachers and many students using the materials and procedures developed in this pilot study could be a most fruitful way of altering both "locks and keys" for inner-city children.

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APPENDICES

APPENDIX I

Science Lessons

THE EFFECT OF EARLY SCIENCE EXPERIENCE ON READING READINESS

Donald B. Neuman

Department of Education

Curriculum and Instruction

University of Wisconsin-Milwaukee

TO THE TEACHER

Introduction

The methods and materials included in this series of science lessons are aimed at achieving three goals. First, it is hoped that each child will be given repeated opportunities to manipulate science materials of many shapes, colors, and forms in order that the development of more acute visual discrimination be facilitated. Second, instruction in the basic science concept, matter, is provided for each child. Third, it is hoped that both pupil and teacher will find interest, excitement, and challenge in the series of lessons that follow.

Before starting the sequence of lessons all the children in your class should be tested for hearing, vision, and color blindness.

Suggestions

1. Activities suggested in each lesson are not intended to serve as a straight jacket for the teacher. However, it is hoped by the writer that the activities for which large quantities of equipment are provided will be used. If variations in the activities seem appropriate, please note the changes you have made and the success that resulted so that changes in the lessons provided in this teacher's guide can be made. This is an experimental unit and you are an integral and important part of the experimental team. Therefore, feel it your task to suggest additions, deletions, and alterations of activities that seem in need of change.

2. Equipment has been provided for each lesson and is included in a series of containers. Check equipment lists and the actual equipment to insure that what is needed has been provided. In most cases, there should be sufficient quantities of basic materials so that each child will have his own equipment. In a few lessons children will work in small groups.

3. As the lessons are being taught, try to keep things moving along. It is not necessary to have every child provide oral feedback for each question or each lesson. Samplings of a child's behavior are usually sufficient to indicate what he does or doesn't know, can or can't do.

4. It is hoped that the science classes will be conducted three to five times per week for approximately thirty minutes each.

Design of Lessons

It is the hope of the writer that children will be given maximum opportunities to discover for themselves the solutions to problems provided in some of the lessons. This can be accomplished best if it is fully understood that no concept included in this unit is so important that a child should be made to feel that he has failed because he has not grasped that particular concept. Manipulation of materials by the child is encouraged. Ideally, most lessons should begin with a "messing around" period of time in which the child gets to examine equipment and perhaps make some independent discoveries. This is followed by a more formal period in which the teacher directs the child's attention to a problem or activity, which the child will then carry on. Although few, if any, children will be able to read, it is suggested that a "science log" be kept where children have made observations. This log can be read back to the children, using their own words, at a later date to remind them of earlier discoveries of activities.

In many lessons children will be given sheets to color or pictures to circle. Please keep a file on each child and retain all written work. In cases where no written work is provided, a sheet will be provided for the purpose of checking off whether or not the child has achieved the objective(s) of the lesson. Note that in most lessons no information regarding achievement of the entire class will be gathered because only a sampling of children will be questioned by the teacher. Don't be overly concerned about this, but in drawing samples of children to evaluate, alternate among all of them and do not concentrate on the same few each time.

Each lesson in this guide consists of objectives, process skills, materials, procedures, and evaluations. Included also is an estimate of the number of twenty to thirty minute periods that will be needed to complete each lesson. A list of all materials needed for each lesson is included at the end of this booklet. Also included are pages for evaluating each lesson as to your perception of successes and failures, need for additional equipment, present condition of equipment, and overall achievement of goals by children evaluated.

UNIT I

Observing and Classifying a Variety of Objects

Lesson #1

Collecting and observing objects around the school. (one period)

Objectives: At the completion of this lesson, a child should be able to (1) state the similarities and differences between two objects; (2) describe one object in as many ways as is possible.

Process Skills: (1) observing; (2) classifying; (3) communicating.

Procedure: Begin with a discussion of what is meant by similar (alike) and different. Have an object hunt in the classroom, school, or in the school area in which children select objects of interest and bring the objects to their seats or a place where they can set the objects down and look at them. There the children examine the objects looking for ways in which they are alike and different. Each child should select three objects and be prepared to state similarities and differences to the teacher and/or class. In addition, a child should be encouraged to describe one object very clearly to the other children in his group. If it is possible, discussions should be held in small groups with a teacher or teacher-aide in charge of each group.

Evaluation: The teacher holds up a series of pairs of objects and calls on volunteers to state differences and similarities. The teacher then holds up a series of single objects and calls on other children to describe these objects in as many ways as possible.

Lesson #2

Observing seeds and plants. (one period plus three weeks or more of ongoing observations)

Objectives: At the end of this lesson a child should be able to describe differences in growth performance between seeds that are watered and those that are not watered.

Process Skills: (1) observing; (2) predicting; (3) inferring; (4) communicating.

Procedure: Begin this lesson by passing out samples of seeds for the children to observe. You might even ask the children to "sort" the seeds. Then call the children over to a demonstration table where you will have the following materials: 6 petrie dishes, a sponge, a sprinkling can, grass seed, bean seeds, corn seeds, and sunflower seeds. Let the children watch as you do the following:

1. Sprinkle grass seed on a moist sponge. It is important that the sponge be moist at the start and continues to be moist throughout the one to three week observation period.

2. Place three bean seeds into a piece of blotting paper in each of two petrie dishes. Moisten the blotting paper in one of the petrie dishes. Do not allow moisture to reach the seeds in the other dish. In similar fashion prepare two dishes containing three corn seeds each, and two petrie dishes containing sunflower seeds.

In addition a chart will be filled in after the seeds have been observed for one week, two weeks, and three weeks.

SEEDS	ONE WEEK		TWO WEEKS		THREE WEEKS	
	Wet	Dry	Wet	Dry	Wet	Dry
Bean	Polaroid Pix	Polaroid Pix	Polaroid Pix	Polaroid Pix	Polaroid Pix	Polaroid Pix
Corn						
Sun-flower						

Each child should be given two radish seeds. One seed will be placed in a petrie dish and will be moistened. The other will be placed in a petrie dish and not moistened in any way. Four children will share each dish. Each child should make a mark on the blotting paper that covers the bottom of each petrie dish so that he will be able to later identify his seeds.

petrie dish base   petrie dish cover   blotting paper

Daily observations should be made for five consecutive days. After germination, the teacher should speak individually with each child, asking the child to describe his or her plant, the effect of

using a wet or dry paper towel, and to try to determine which is the root and which is the shoot.

Evaluation: Ask each child to predict what will happen if unwatered seeds are watered. Have the child wet the blotting paper of the "dry" petrie dish after their predictions have been made. Encourage each child to make a drawing, painting, or sketch of what he thinks the plants will look like in five days.

Lesson #3

Observing, naming, and identifying colors. (three periods)

Objectives: At the end of this lesson, a child should be able to name and identify the following colors: red, blue, green, yellow, orange, brown, purple, and black.

Process Skills: (1) observing; (2) inferring; (3) communicating.

Procedure: Each child should receive a set of felt pieces in the eight colors to be learned. The teacher will name the colors and ask each child to hold up the felt piece that is that color. The teacher will hold up colored pieces of felt and ask children to name the color. Children can work in pairs naming and identifying the colors (if possible put a child who knows his colors with one who does not know his colors).

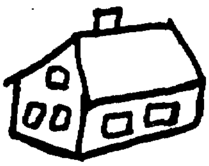
Give each child small pieces of colored construction paper in the eight colors to be learned. Using quart jars filled with water and mixtures of red, blue, green, and yellow food coloring, prepare each jar in full view of the children to represent the eight colors to be learned. Point to a jar and have the children hold up the piece of construction paper that coincides with that color. Call on volunteers to name that color.

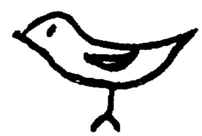
Color	Food Colors (mix)
red	red
blue	blue
green	green
yellow	yellow
orange	red and yellow
purple	red and blue

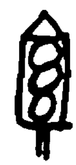
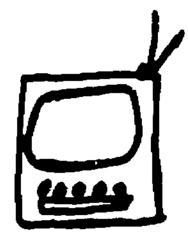
Game: Divide the class into groups. Using a box with a hole cut in the top, call on a child from one group to draw a slip of paper with a color drawn on it from the box. The child can give his group one clue to the color (but he can't tell what the color is). Each child

should get one or more turns to draw a color from the box and give his clue.

Evaluation: A ditto master of the pictures below. Instruct the children selected for evaluation to color (or circle) each with a specific color, using the crayons provided. Write the children's names on papers or if possible have them write their own names. Note: crayons provided in this lesson should be retained in the classroom since they will be used again in many of the later lessons.





Lesson #4

Observing, naming and identifying two dimensional shapes. (three periods)

Objectives: At the completion of this lesson, a child should be able to name the two dimensional shapes, rectangle, triangle, square, and circle when shown examples of these shapes.

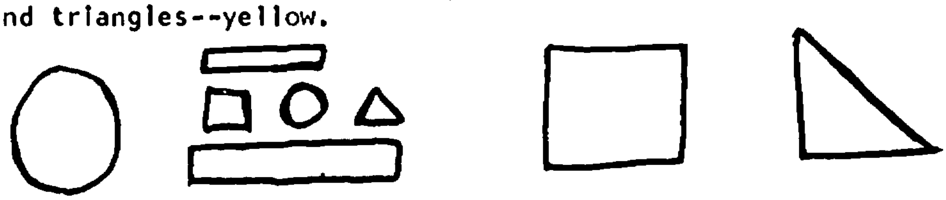
Process Skills: (1) observing; (2) communicating.

Procedure: The teacher will use large wooden two dimensional figures while each child has his own small two dimensional figures of a rectangle, triangle, square, and circle (each child will get two of each: one larger and the other smaller). Children should be given an opportunity to manipulate the figures for a few minutes and describe similarities and differences between them. Children should be given the opportunity to name the figures if they can and to match theirs with the teachers. Using a light or preferrably sunlight, and a translucent screen, hold various figures up behind the screen at a variety of angles (not straight on). Call on the children to identify the figures and justify their choice. Ask the children to look around the classroom and point to or touch objects that are examples of the shapes being studied and ask them to name the shape. Using a variety of shapes cut to various dimensions and in a number of colors, have children paste the shapes on colored construction paper to make a picture. Have them note how shapes can be combined to make new shapes.

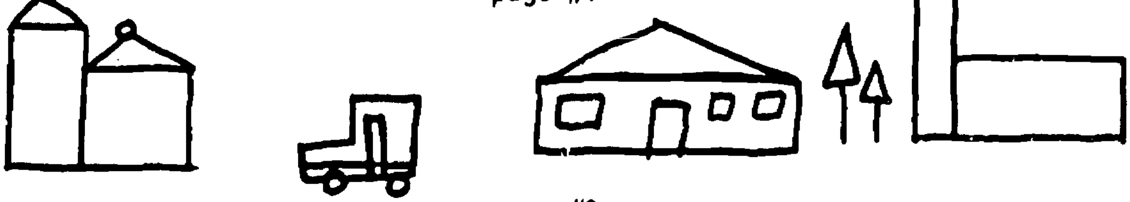
Game: Divide the class into groups. Use the grab boxes filled with a variety of the small wooden shapes used previously in this lesson. A child reaches into the bag and selects a shape. Without

looking at the shape, the child must identify it. Then the shape's color must be identified. Every child should get one or more chances.

Evaluation: Each child receives a copy of each of the sketches below. Using his crayons, he is to color in or circle each shape in the following way: circles--green; squares--blue; rectangles--red; and triangles--yellow.



page #1



page #2

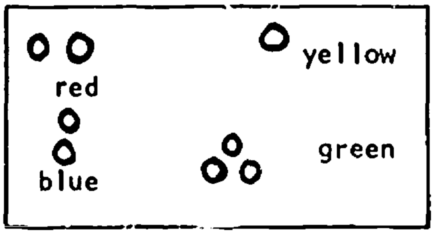
Lesson # 5

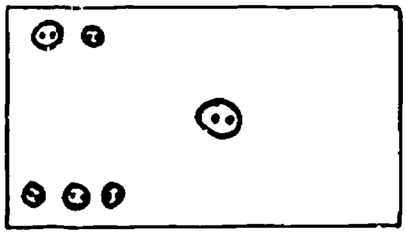
Classifying buttons. (two periods)

Objectives: At the completion of this lesson, the children should be able to sort a set of objects according to one physical characteristic (size, color, number of holes).

Process Skills: (1) observing; (2) classifying.

Procedure: Each child should be given a small baggie containing an assortment of buttons and a small cardboard tray. The buttons should be placed on the tray and the children allowed to look at and manipulate the various buttons. Observe what the children are doing and encourage them to "play with the buttons." Ask the children to arrange the buttons in some way on their boards. Call on children to describe how and why they have made their arrangement. Tell the children this is called sorting. After all the children have sorted their buttons in one way (according to one property), ask them to sort their buttons in another way. Get some feedback from the children about how they sorted the buttons the second time and how this was different from the first time. Call the children to some place in the room where a series of two styrofoam "boards" have been arranged with buttons by placing a toothpick through a button hole (use large buttons). One "board" is sorted by colors. The other "board" is sorted according to the size of the button.





Draw buttons at random from a grab bag prepared for this exercise and call on a child to place the button where he thinks it belongs on either "board." Ask the class merely whether they agree or disagree. If someone disagrees, ask them to change the location and then discuss it. Note: In the grab bag you should place buttons that are both similar to those on the boards and different from them. In this way children can make decisions about the placement of buttons on the basis of size and color and not just match buttons to identical ones already on the styrofoam boards.

Evaluation: Pass out sets of ceramic tiles in grab bags along with the trays. Ask children to sort the tiles. Discuss the sorting arrangements with each child to determine his ability to classify.

Pass out shapes of different sizes and colors cut from construction paper (you may want to use sorting trays). Ask the children you evaluate to sort the shapes in any way they want. Ask each child to explain his scheme.

UNIT II

Defining Matter and Properties of Matter

Lesson #6

Defining matter. (two periods)

Objectives: At the end of this lesson, each child should be able to state that all objects are made of materials and that materials is another word for matter. All objects in the universe; the rocks, the water, and the air are forms of matter.

Process Skills: (1) communicating; (2) observing.

Procedure: a. Bring the children together in a pow-wow. Each child should have a balloon, a piece of white cloth, a pencil and a shell. Several plastic glasses with water should be nearby for children to observe. On a chart prepared in advance are listed properties (in drawing or picture form as well as in words), such as soft, smells, colored, has weight, has a taste, takes up space, along one axis.

Along a second axis are pictures of the objects the children have before them. The teacher asks the group to help her fill in the chart. If an object has a particular property, the teacher places a red dot in the square. If the object does not possess the property, the teacher leaves the square empty. It will be noted that all of the objects have weight (really mass) and take up space. This can serve as a definition for the children. Another equally valid definition of matter is: all objects in the universe, rocks, air, water, and etc., are made up of materials and we call these materials matter.

In addition, you should also do the following: b. Bring the class together as a group. Using the objects from Unit I, plus additional objects, sort these into two piles on the basis of those things that are made up of one material (one group) and those things composed of more than one material (second group). After sorting a few of the objects, let the class decide where various things should go and ask them why. Tell the class that things are being sorted according to their materials; some things are made of one material and some are made of more than one material. Material is another word for matter (which is a more scientific word). Let the children go back to their seats or place mats and give each child a piece of wood, metal, plastic, and a magnifying glass. Call on volunteers to describe the objects in terms of the kind of material of which it is made. Discuss similarities and differences.

Evaluation: Discuss with individual children what is matter. Have objects representing the three states of matter; solid, liquid, and gas available to determine whether children actually comprehend the meaning of matter.

Lesson #7

Defining "Properties of Matter." (three periods)

Objectives: At the end of this lesson, each child should be able to state that matter is made up of properties and be able to name two contrasting properties of the three sets of objects provided: hard and soft; shiny and dull; warm and cold. Furthermore the child should state that properties can be seen or felt or smelled.

Procedure: Hand out to each child a tray and material set #1. This set consists of a baggie containing a cotton ball, a piece of cloth, a piece of yarn, a small piece of plasticene, a rock, a shell, a piece of wood, and a piece of metal. Ask the children to look at their materials and to sort them on the tray. Ask children to tell how they have sorted their materials. Try to develop the idea that some objects are hard and some are soft; also that hardness/softness is a property of matter. Collect the materials.

Hand out material set #2. This set consists of a baggie containing a piece of aluminum foil, a shiny metal button, a highly shined brass disc, a wooden disc, a piece of construction paper, and a plastic button. Ask the children to sort their materials and describe how they have sorted them. Casually discuss the word property by asking some children what property they used to separate the objects from one another (shiny--dull). Collect these materials.

Place two plastic containers near each group of three children (have paper toweling ready). Into one plastic container pour warm water. Into the other pour cold water. Ask the children to decide within their group how the two containers of water are similar and how they are different. Then, hand each group two pieces of soft wood. Tell the children that one of the pieces had been kept in a dark corner of the room while the other one had been in the sun or near a radiator. Ask the groups to decide which piece had been in the sun (or near the radiator) and which had not. Discuss with class and develop concept that water--a LIQUID--can be cold and can be warm; so can wood--a SOLID --be cold and also be warm. Cold or warm is a property of matter. Collect all materials.

Place the following objects at three or four stations in the room for the children to see: granite pieces, wooden block, pencil, plastic piece, set of marbles, cotton ball, ball, towel, aluminum foil, bowl of warm water, and bowl with cold water. Assign children to these stations with a teacher or assistant present at each one. At each station, children should work in groups of two. The children face away from the table where the objects have been placed and one child is handed an object by the teacher. This child must describe the object to the other children, one descriptive word at a time. The first child to identify the object has the next turn to be describer. The other children in the group must listen to the descriptive words being used. The teacher should make a list of the words used. Instruct the children to listen for or think up good clue words. After all the teams have had a chance, call all the children to a pow-wow to discuss words used to describe the properties that made up the objects. Tell the children that words such as soft, hard, red, and etc., are called properties and that all matter is made up of properties. Differences in things are due to differences in properties.

Evaluation: Hand out an evaluation sheet on which a sketch of a pencil has been drawn. In addition pass out a pencil to each child. Give the class the following instructions: Put a green mark on the part you think is hard; blue--soft; red--shiny; orange--dull; brown--warm; black--on the part that is cold.

Lesson #8

Experiences with solids. (two periods)

Objectives: At the end of this unit, a child should be able to sort (a) three kinds of wood: pine, oak, and walnut; (b) three kinds of metal: aluminum, brass, and iron; (c) two kinds of rocks: quartz and granite; (d) and two kinds of shells: snail and scallop; and (e) state that these objects are examples of solid matter.

Procedure: Hand out pieces of pine, oak, and walnut to each child in the class and packets of sawdust and shavings to each pair of children in the class. Also give each child a magnifying glass. The child should study each type of wood, sawdust, and shavings under the magnifying glass. Children should be encouraged to name the kinds of wood and should be able to match the sawdust and shavings with the wood from which it came. Speak to individual children and ask them to name or describe the properties of the three different kinds of wood.

Hand out baggies containing pieces of aluminum, iron, and brass. Have the children observe these metals under a magnifying glass. Suggest that they note how the metals are similar and how they are different. Tell the children the names of these metals but do not dwell on the names. Discuss the similarities and differences among the metals with individual children.

Hand out the shells and rocks. Name each for the children and then ask them to examine each of the objects using the magnifiers. Ask the children to try to draw a picture of each shell. Have a live snail in an aquarium present so that the children can see what the shell represents.

In a "pow-wow," review the word "properties" then ask the children to name the properties of the various objects observed in this lesson. How are they all alike and how are they different? Ask the children if they know what objects with properties such as hardness, definite shape, magnetic attraction, shininess, and etc. are called. If there is no answer, tell the children the objects are called solid matter or solids.

Evaluation: Use the evaluation sheets containing sketches of wood pieces, wood chips, and sawdust. Hold up the large piece of walnut and ask the child to circle all the drawings on the page that are made of this material in red. Hold up the oak and have them circle the oak examples in blue. Hold up the pine piece. Circle all pine in green. At six stations in the room, place a piece of aluminum foil, a brass screw, and an iron nail. Allow the children to examine these objects. Again question a sampling of children as to the composition (metallic) of these objects. Next, use the evaluation sheets containing sketches of shells. Hold up a snail shell and have the child circle all the shells like the snail shell in orange. Hold up the scallop shell. Circle examples of scallop shells in black. Circle any other shells in yellow.

Lesson #9

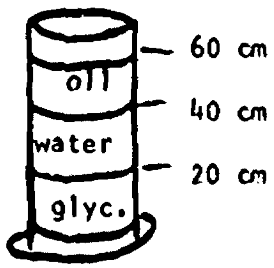
Experiences with liquids. (two periods)

Objectives: At the end of this lesson, the children should be able to identify water, oil, and glycerin by name and state one property of each that enables them to make the identification. The children should also be able to state that water, motor oil, and glycerin are liquids.

Procedures: A. Each child or pair of children should receive a tray covered with wax paper, a small bottle of water, oil, and glycerin, small sticks (popsicle type), and three droppers. The child should use a separate dropper for each liquid and be allowed to examine small quantities of each liquid without teacher instruction other than a caution to use only small amounts of liquid for this part of the lesson. Hand out blotting paper and instruct the children to place one drop of each liquid on the paper. Name each liquid as the child places the drop on the paper. Ask the children to describe what happened. Using wax paper, ask the children to place small quantities of each liquid in the corners of the wax paper. Ask the children to figure out how many different ways the three liquids can be mixed and then to mix them using droppers and sticks. Ask for descriptions of the mixtures. Do they all mix?

B. Fill two quart jars with water. Place one on a hot plate and heat up the water. Let the other jar of water remain cool. As the children watch, add three drops of food coloring to each jar. Ask the children to describe the results.

C. Place 20 ml. of each of the three liquids, water, oil, and glycerin into a graduated cylinder one at a time. Do this slowly, allowing each liquid to drain down the sides of the cylinder. Add food coloring to the water (green), before pouring it into the graduated cylinder. It is recommended that oil be poured in first followed by the glycerin and then the colored water. Mark each interface level with a china marker or tape. Have the children identify the liquid in each layer. After clear interfaces between the three liquids appear, cover the top of the cylinder and shake the cylinder vigorously. Observe for five minutes. Then allow it to stand over night. Observe the next day. The children should note that the water and glycerin mix and do not separate out.



Evaluation: Using a sampling of children from the class, let each child individually examine three clear liquids, glycerin, mineral oil, and water. Ask each child if the liquids are all the same. Ask the child to describe a way to find out. Try out the suggested procedure of each child and see if he can identify any or all of the liquids.

Lesson #10

Experiences with gases. (three or four periods)

Objectives: At the end of this lesson, the children should be able to state that air is a gas; that air presses on things; and that different gases behave in different ways.

Procedure: A. Give each child in the class a large paper bag in which has been placed a baggie containing a small piece of apple. Both the baggie and the paper bag should be completely inflated and the paper bag securely tied. The child should be encouraged to infer what is inside the bag. After the inferences have been recorded by the teacher on a "science log," each inference should be discussed and evidence for that inference presented by a child. Rather than telling, open one of the bags and show the children what it contained. Ask why it was so difficult for some children to find out what was in the bag.

B. Pass out a large baggie, a party whistle, and several rubber bands to each child. Tell the children their job is to make the party whistles blow without using their mouths. Observe children's behaviors. Call on volunteers to show their method. Try to elicit from the class what this tells us about air.

C. Place iodine crystals into two quart jars while the children are watching. Cover both jars. Place one on a hot plate and allow the other to remain cool. Record the children's observations on the "science log." Ask the children to summarize what this all means.

D. Using a can of spray deodorant, spray a jet of deodorant (5 seconds) directly toward the ceiling. Ask the children to raise their hands when they can smell the odor. Ask the children for an interpretation of what this means. Was a gas involved?

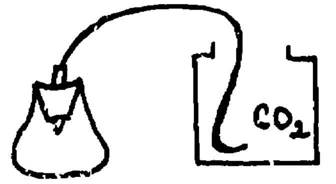
E. Before the start of the science lesson fill one balloon with air and a second with freon from the can of freon provided. Call on a child to examine the balloons and tell if they are the same. Then drop the two balloons. Ask the children for an interpretation of what they just saw and what it means. Hand out two balloons to pairs of children. Ask them to blow up one of the balloons. You fill the other from your freon can. Let the children experiment with the two balloons.

Demonstration: Prepare two bottles (quart jars) of gas. One bottle will contain carbon dioxide, the other oxygen. To get the carbon

dioxide into the jar, do the following. In an erlenmeyer flask, place 1/2 cup of sodium bicarbonate (baking soda). Pour vinegar or a mild acid into the flask until bubbles are vigorously generated. Cap the flask with a one hole rubber stopper to which a rubber hose has been connected. Run the rubber hose to one of the quart jars and collect the carbon dioxide for a few minutes. Cover the jar with a cap. The other jar should merely be covered as is. For the demonstration, place a burning wood splint into each of the jars after the covers have been removed. Ask the children to describe what happened to the flame in each jar. What does this mean?

Note: Do not generate the CO_2 in front of the children. However, the CO_2 should be generated shortly before the demonstration. Since CO_2 is heavier than oxygen and nitrogen and the rubber hose is placed in the bottom of the jar, the CO_2 will drive out the other gases.

erlenmeyer flask



quart jar

Evaluation: Children should be called individually to a convenient part of the room, shown the following materials, and asked the following questions:

1. Party whistle and baggie.
   a. Why did the whistle blow when we pressed on the baggie?
   b. What does that tell you about air?

2. Four pictures of a faucet and a glass of water. Tell each child that these are drawings made while watching a glass of water fill up. Ask him to place the glasses in order from left to right as they looked while they were being filled. When this has been done ask each child to point to a solid, liquid, and gas in one of the pictures.

UNIT III

Using Quantitative Measures in Observing Matter

Lesson #11

Developing the concept, serial order. (three periods)

Objective: At the end of this lesson, each child should be able to use the symbols greater than, less than, and equal to, to order a

series of three or more objects. The child should also be able to serial order sets of dowels and corks.

Procedure: Using a flannel board show the children three figures, a triangle, a diamond, and a pentagon. Ask the children how the figures are alike and how they are different. Place the figures in a row with the triangle on the left, the diamond in the middle, and the pentagon on the right. Ask the children if any of them can tell why the figures were placed in the order that you placed them. Show the children a figure of a hexagon. Ask them where to place this figure (on the line) and why. Develop the idea that the figures are ordered according to the number of sides they have and that the class will order all things from left to right. (You do not have to use the terms left and right.) Reverse all the figures on the flannel board so that the hexagon is on the left and the triangle is on the right. Ask the children if this is an order. Tell them that any arrangement, either from largest to smallest or smallest to largest is called a serial order.

Show the children a dowel of large diameter, medium diameter, and small diameter (all are the same length). Arrange the dowels in a serial order and ask the children to identify the property used for making the order. Call on four children, of different heights, to come to the front of the group. Call on a volunteer to serial order these children and call on another volunteer to name the property used to make the serial order. Show the children four rubber balls of different sizes and call on volunteers to order the balls and identify the property used to make the order.

Place a super ball, a rubber ball, and a lump of clay on a table in front of the children. Bounce each on the table several times and then place them in order according to their "bounciness." Ask the children why you placed them in the serial order indicated. If no one can identify the property of bounciness tell them the property and call on a volunteer to place them in a different serial order (from least bouncy to most bouncy).

Return to the flannel board and the four figures (triangle, diamond, etc.). Show the children the symbols for "greater than" ($>$) and "less than" ($<$) and show them how the symbols can be used instead of words. Note: $1 < 2$--one is less than two; $4 > 1$--four is greater than one.) Practice using the symbols with a number of different serial orders. Introduce the symbol "equals" and show how it can be used with objects that are of equal size or objects that have the same number of sides. For this use the flannel board and the large, medium, and small triangles provided. The triangles can be ordered according to size or can have equal signs between each pair when the number of sides is the property used for comparing the order.

Give each child a baggie containing a set of five dowels, each of a different length. Don't give the children any directions at first.

Let them "play" with the dowels. If any appear to be ordering the dowels in some fashion ask them what property they are using. Then ask the entire class to serial order the dowels from left to right. After the children have ordered the dowels, pass out baggies containing five corks each and symbols for greater than, less than, and equals. Ask the children to serial order the corks from left to right and place the correct symbol between each pair of corks. Ask individual children to tell about their order and encourage them to use the phraseology bigger than, smaller than or same as.

Evaluation: A. Give each child five strips of colored paper of various lengths and a piece of plain white paper. Ask the child to paste the strips on the paper in a serial order. Encourage those who want to or are able to use the symbols to paste symbols between each strip on the paper.

B. Give each child five strips of colored paper of various widths (all are the same length) and a piece of white paper. Again, instruct the children to paste their strips on the paper in a serial order and encourage children to paste symbols between each pair of strips.

Lesson #12

Serial ordering objects on the basis of roughness or smoothness. (two periods)

Objective: At the end of this lesson, a child should be able to serial order a given set of objects on the basis of the property smoothness or roughness.

Procedure: Hand out a baggie containing four pieces of material (burlap, wool, cotton, satin) to each child. Ask the children to order the material on the basis of one property. Discuss. (Do not reject orders that are based on properties other than smoothness. Develop the idea of smoothness when the children have ordered the material according to that property.) Hand out a piece of plain paper and a baggie containing six grades of sandpaper (small pieces). Ask the children to paste them onto the piece of paper in a serial order and draw the appropriate symbol between each piece of sandpaper if they can. Discuss individually with the children what they have done. From a large bag have each child draw out four samples at random. The bag contains small pieces of sandpaper (two grades), construction paper, wrapping paper, and waxed paper. Ask the children to serial order the four samples they have chosen on the basis of their roughness or smoothness. Discuss with the children on an individual basis what they have done.

Evaluation: Four cards each having a different grade of sandpaper pasted on it will be given to each child. The child will be asked to place the sandpaper in a serial order. Symbols will be

available for those children who are able to use them. Children will be encouraged to place the proper symbols between cards.

UNIT IV

Experimenting with Matter

Lesson #13

Comparing halite, salt pellets, and table salt. (three periods)

Objectives: At the end of this lesson, a child should be able to distinguish between halite, rock salt (pellets) and table salt in their usual form and state that they are identical to one another when in the crushed or granulated form. The child should be able to state that objects may be the same even though they look different.

Procedure: For this lesson (and the next two lessons), the children should work in groups of three of four. Each group should receive several pellets of salt, several pieces of halite, a small amount of table salt, several magnifying glasses, a pestel and mortar, and pieces of dark colored construction paper. Each child should examine the various forms of sodium chloride under a magnifying glass. Then the salt pellets should be crushed but one piece saved for examination under the magnifier. For this task, children should use the pestel and mortar. By placing the pellets on dark paper, the salt can be more easily studied. A similar procedure should be followed with the halite. On a third piece of dark colored construction paper the children should examine the granules of table salt. It might be effective merely to give the equipment and materials to each group of children and ask them initially to decide if the three samples were made of the same kind of basic material or not. The children can be questioned in their groups or individually while the teacher circulates throughout the room and notes the way each group attacks the problem.

Evaluation: Each child who is evaluated should: (1) Circle all the pictures that are salt pellets for sure in orange. (2) Circle all pictures that are halite for sure in green. (3) Circle the pictures in which it can't be determined for certain whether it is a salt pellet or halite in blue.

The teacher should: (1) Ask each child evaluated what his evidence is for choosing a picture as being a salt pellet or halite; (2) Ask the individuals why they can't tell granulated salt pellets from granulated halite from granulated table salt.

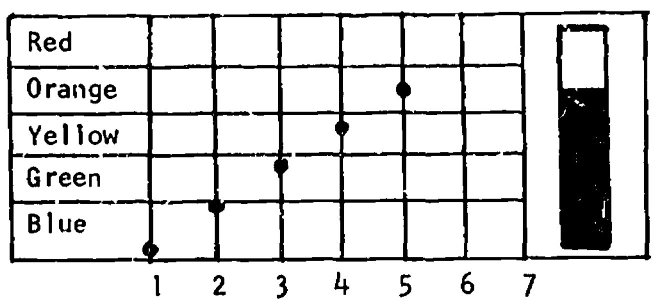
Lesson #14

Observing ice and water. (two periods)

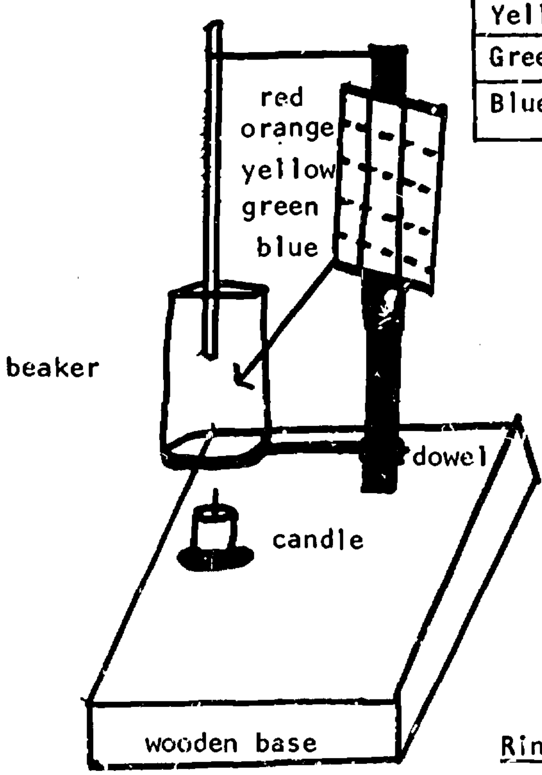
Objectives: At the end of this lesson, each child should be able to state that ice is the solid form of the liquid water.

Procedure: Each child is given a plastic cup of crushed ice and asked to make as many observations as he can about the cup and what is in it. The children should be encouraged to use all their senses. Discuss observations as a class. Divide the class into ten groups. Give each group a thermometer. Discuss what it is used for and ask groups to make observations on a glass of warm water into which crushed ice is slowly added. Discuss these observations.

Bring the group together in a semi-circle for the following demonstration. You will need three large beakers: one two-thirds filled with cold water; another two-thirds filled with crushed ice; the third, one-third filled with crushed ice and one-third water, into which a tablespoon of rock salt has been dissolved; three ring stands and accompanying holders; three thermometers; three candles; three thermometer data apparatus; and one clock with a sweep second hand.



Thermometer Data Sheet



Ring Stand Apparatus

The children will be divided roughly into three equal groups. Each group will observe one of the three beakers. In each group one child will be designated to observe the thermometer in the liquid, one child will take readings of a clock at one minute intervals, another child will adjust the thermometer on the data chart to coincide with that in the liquid at one minute intervals, and the fourth child will mark the data chart. The teacher will light the candles and place them under the beakers. The clock watcher in each group will tell the two thermometer watchers when a minute has gone by and they will adjust the data thermometer to coincide as closely as possible with the actual thermometer. The marker will place a point on the chart at the intersection of one (minute) and the point at which the data thermometer has been adjusted. This should continue for seven minutes. After the readings have been recorded on the chart, a child should be asked to connect the points with a line. This should be done in each of the three groups. Readings should be taken a second time to verify the first readings. A discussion should be carried out in which differences in readings among the three beakers are discussed. The children should be able to tell what happened to the ice in the two beakers containing ice. It may also be helpful or necessary to repeat the experiment using different children as data collectors.

Evaluation: You will have a series of pictures of ice at various stages of melting. Each stage will be on a different card. The cards can be shuffled into any order and individual children asked to arrange them in the proper chronological sequence. This should be done individually with a sampling of children.

Lesson #15

Experimenting with gases. (two periods)

Objectives: At the end of this lesson, a child should be able to state the rule that a gas takes up space.

Procedure: Begin by passing out two syringes connected by a plastic tube to each child. Ask the children to manipulate the syringes and make observations. Discuss what the children have observed and ask what was in the syringes that caused the things that the children observed. Remind the children that air is a gas (or combination of gases). Call the children together for a short demonstration. Place an inverted beaker of colored water (covered by a 3 X 5 card) into an aquarium of clear water. Carefully slip the card out from the mouth of the beaker. Slip a piece of tubing connected to a large syringe into the beaker (while it is under water and being careful not to tilt the beaker any more than is necessary) and push in the plunger forcing air into the beaker. Remove the syringe, pull out the plunger, place the tube into the glass and force more air into the beaker. Continue doing this until the water has been forced out of the glass. Ask the children for their observations. In their groups of four, give each

group a plastic aquarium, an empty beaker, a syringe, and some plastic tubing. Ask the children to try to fill the beakers with water using the equipment they were handed. They must place the beaker into the aquarium straight down, not at an angle, otherwise the air in the beaker is forced out and water runs in as the beaker is being submerged. Discuss what has happened with individual groups.

Evaluation: Call individual students to a corner of the room. Place a piece of cloth in the bottom of a beaker and plunge the beaker straight down into a small aquarium of water. Ask the children whether the cloth will be wet or dry and why. Ask each child to name the three kinds of matter studied in the science unit.

MATERIALS NEEDED FOR EACH LESSON

The materials needed for each lesson are provided in color-coded boxes and small containers. Each large box contains six of the similarly color-coded containers. Each large box is marked with the unit number and each of the small containers has a lesson number indicated on the container cover.

UNIT I Observing and Classifying a Variety of Objects (Blue).

Lesson 1 - Collecting and observing objects around the school. Materials needed for this lesson should be those usually found in or around the school premises.

Lesson 2 - Observing seeds and plants. 2 large sponges; quantities of bean, corn, radish, grass, and sunflower seeds; large chart; Polaroid swinger camera and two rolls of (eight each pack) film; 40 petrie dishes; blotting paper; paper toweling.

Lesson 3 - Observing, naming, and identifying colors. 30 sets of felt pieces (eight colors per set in a small package); 30 sets of colored construction paper; 8 quart jars; food coloring; grab box; 30 boxes of crayons; set of evaluation sheets.

Lesson 4 - Naming and identifying two dimensional shapes. 30 sets of wooden shapes (in four colors and two sizes); large set of wooden shapes for the teacher; silhouette screen; grab boxes; 30 sets of construction paper cut outs; evaluation sheets.

Lesson 5 - Classifying buttons. 30 sets of buttons in individual packages; 30 cardboard trays; 2 styrofoam boards; straight pins; teacher set of buttons; 3 cloth grab bags with tie strings; 30 sets of ceramic tiles in packages; sets of construction paper for evaluation.

UNIT II Defining Matter and Properties of Matter (Red).

Lesson 6 - Defining matter. 30 sets of objects (balloon, piece of cloth, shell, and a pencil); 8 plastic cups; large chart, assortment of objects (from your classroom); set of 30 objects (wood, plastic, metal, and magnifying glass).

Lesson 7 - "Properties of Matter".

30 trays: 30 sets of hard/soft objects; 30 sets of shiny/dull objects; 10 sets of plastic containers (2 containers per set); 10 each - granite pieces, wooden blocks, pencils, pieces of plastic, cotton balls, rubber balls, paper towels, aluminum foil, plastic containers, marbles; evaluation sheets.

Lesson 8 - Experiences with solids.

30 cardboard trays; 30 sets of wood including small pieces of pine, oak, and walnut and packets of saw-dust and shavings of pine, oak, and walnut; 30 sets of metals including aluminum, brass, and iron; 30 small magnets; 30 sets of rocks including quartz and granite; 30 sets of shells including snails and scallops; evaluation sheets.

Lesson 9 - Experiences with liquids.

30 cardboard trays; waxed paper; paper toweling; 15 sets of small bottles (3 per set) containing glycer-in, water, and motor oil, wooden sticks; 15 sets of eye droppers (3 per set); four quart jars; food coloring; electric hot plate; 100 ml. graduated cylinder.

Lesson 10- Experiences with gases.

30 sets of paper bags, baggies (apple will be pro-vided by teacher) and string; 30 sets large plastic baggie, party whistle, and rubber bands; iodine crystals; two quart jars; electric hot plate (from Lesson 9); balloons (large size); can of freon; erlenmyer flask; 1 hole rubber stopper with metal tube in place; rubber delivery tube; baking soda; small plastic bottle of dilute acetic acid; wood splints; matches; evaluation sheets.

UNIT III Using Quantitative Measures in Observing Matter (Yellow).

Lesson 11- Developing the concept, serial order.

Flannel board; cut out figures in variety of shapes, sizes, and colors; 30 sets of dowels in variety of lengths; 1 set of four rubber balls; 3 sets of super balls, rubber balls, and Plasticene; 30 sets of cork stoppers in variety of sizes; 30 sets of symbols ($>$, $<$, =); 1 large set of symbols; assortment of paper strips for evaluation; bottle of paste.

Lesson 12- Serial ordering objects on the basis of roughness and smoothness.

30 sets of materials of various roughnesses; large

jar of paste; 30 sets of various grades of sand-
paper; 30 sets of paper-like materials of various
roughnesses; evaluation cards.

UNIT IV Experimenting with Matter (Green).

Lesson 13- Comparing halite, salt pellets, and table salt.
10 sets consisting of three plastic containers
each of halite, salt pellets, and table salt;
30 magnifing glasses; 10 sets of pestels and
mortars; sheets of dark colored construction
paper; evaluation sheets.

Lesson 14- Observing ice and water.
30 plastic cups, 10 thermometers; 9 - 250 ml
beakers; 30 large charts; 3 ring stand apparatus;
1 large clock with sweep second hand; 3 magic
markers; 3 hearing candles; 3 specially prepared
thermometers; evaluation materials.

Lesson 15- Experimenting with gases.
30 sets of syringes and rubber tubes; food coloring;
3 X 5 cards; 100 ml. beaker; small aquarium; large
syringe with delivery tube; 10 small one-gallon
aquaria; 10 plastic cups.

LESSON EVALUATIONS

Child	Lesson # [X] achieved all goals [/] partially achieved goals [ ] did not achieve any goals														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15

APPENDIX II

Results of Metropolitan Reading Readiness

Results of Metropolitan Reading Readiness

Experimental Group

Name	Sex	IQ*	Test Scores Subtest 1	2	3	4	5	6	Total Score
Natalie	F	119	8	11	13	16	14	8	70
Jackie	F	117	9	7	9	11	8	4	48
Syeeda	F	110	14	14	13	15	20	11	87
Donna	F	107	13	12	8	15	17	5	70
Alan	M	106	13	12	9	15	21	7	77
Kenny H.	M	105	7	8	6	6	8	1	36
Kevin	M	104	13	13	11	14	19	4	74
Cynthia	F	102	10	9	8	11	6	7	51
Earline	F	101	11	12	10	15	12	8	68
Sue Ellen	F	101	11	9	10	16	11	4	61
Dorothy	F	99	11	11	5	13	13	2	55
Cecil	M	95	10	9	0	9	10	1	39
Dennis	M	95	10	11	6	3	4	4	38
Sandra	F	94	13	8	6	7	9	6	49
Margaret	F	93	10	7	8	14	8	4	51
Antonio	M	92	10	13	3	9	9	3	47
Kenny M.	M	90	9	7	8	8	11	2	45
Darin	M	89	6	10	0	7	5	3	31
Peggy	F	85	12	7	7	12	8	3	49
Jerry	M	71	9	9	3	7	10	0	38

*Pintner-Cunningham, Form A

Control Group

Name	Sex	IQ*	Test Scores Subtest 1	2	3	4	5	6	Total Score
Michael	M	115	8	9	13	16	9	10	65
Ryan	M	112	7	10	11	11	10	8	57
Timothy	M	112	8	8	8	6	4	5	39
Gladys	F	109	8	10	9	13	17	8	65
Anita	F	109	9	12	14	5	8	3	51
Luther	M	107	9	8	11	8	0	5	41
Coleman	M	104	9	9	9	14	13	4	58
Adele	F	104	10	12	11	11	9	5	58
Helen	F	104	9	11	11	15	10	5	61
Damita	F	99	8	10	7	3	7	3	38
Gwen	F	96	3	7	10	6	7	5	38
Richard	M	95	7	10	5	3	3	1	29
Rodney	M	94	8	9	9	7	4	2	39
Murtiss	M	93	6	8	12	5	5	7	43
Robert	M	93	5	7	8	6	6	5	37
Stephanie	F	92	6	11	12	12	12	4	57
Eric	M	92	0	9	6	4	8	4	31
Sharon	F	91	7	10	4	5	0	2	28
Tommy	M	84	3	9	9	13	9	4	47
Ladonna	F	81	7	7	6	11	8	3	42

*Pintner-Cunningham, Form A